

## SALIX CORDATA × SERICEA.

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THE general aspect and specific characters of *Salix cordata* and *S. sericea* serve to distinguish them quite readily. There have sprung up between them numerous intermediate forms, hybrids, and races, crossing with each other and with the parental forms, resulting in an almost inextricable confusion, on the one hand approaching *S. sericea*, on the other *S. cordata*. This free intermixture resulting in more or less good varieties in different localities is no doubt the sufficient explanation of the confusion that results from reading the various descriptions of *S. cordata*. As in all probability the descriptions were all founded upon specimens collected from regions where both of the species are native, it is absolutely certain that about the same complications must have been present as are found prevailing in the vicinity of St. Louis.

During the preparation of my paper last year on *S. Missouriensis* and *S. cordata*<sup>1</sup> I gradually got the feeling of the great necessity of further investigation of this subject. I therefore made collections in bud, in flower, and in mature leaf, of several hundred marked plants, taking notes of every detail. The summary at the end of this paper is but a partial transcript of the notes of eighty-two of those collected. In the Engelmann Herbarium of the Missouri Botanical Garden there is a long letter written about 1880 by the late M. S. Bebb, in which he refers to the frequent hybridization of *S. cordata* with *S. sericea*. He gives a fairly good description of these hybrids, but appears to have limited too much the extent of their influence. For example, he limits the height to 9<sup>ft</sup>, while some of our specimens here rise to 25 or 30<sup>ft</sup>. The specimens he contributed all

<sup>1</sup>Trans. St. Louis Acad. Sci. 7:—, 1895.

show more or less silkiness of capsules, and where there is silkiness of capsule or leaf, even but sparingly, the problem is easy. The evidence now at hand, however, compels the extension of the idea of contamination. By taking account of every possible character, we find that hybrids, or rather intermediate races, include many examples having capsules perfectly smooth, and all but the youngest leaves likewise perfectly smooth.

Upon the *S. cordata* side of our problem it is perhaps impossible as yet to form a proper conception as to its typical character, either from description or observation. An intelligible and comprehensive description of it is yet to be written, and must be founded upon specimens collected from regions where *S. sericea* is not found.

Fortunately in the characters of *S. sericea* we have rigid stability, a fact which furnishes us an invaluable guide to a partial exploration of the mazes of hybridization. Having examined specimens from Massachusetts, New York (Ithaca), southern Pennsylvania, Ohio, Michigan (Detroit and Port Huron), Illinois (Chicago), Missouri (Pilot Knob and St. Louis), and the Rocky mountains, I have found no noteworthy variation. Specimens of *S. cordata* were examined from New Brunswick, Niagara Falls, Ohio, Illinois, Iowa, Missouri, Minnesota, Colorado, Idaho, Oregon, California, and Kew Gardens.

Notwithstanding the variability of *S. cordata*, taking a general view of it together with its varieties, including var. *vestita* and its hybrids with *S. sericea*, there is presented as a whole such an *ensemble* of stem, spread, color, foliage, flower and fruit as to enable one to distinguish it easily from all other species. The interest in this paper must lie therefore rather in biology than in systematic botany.

Assuming but one form of *S. cordata*, and one good variety, viz., var. *vestita*, and knowing the freedom with which each crosses with *S. sericea*, we shall have, theoretically, the following combinations: *cordata*  $\times$  *sericea*, *cordata*  $\times$  *vestita*, *sericea*  $\times$  *vestita*, and *cordata*  $\times$  *sericea*  $\times$  *vestita*. I think these combinations are recognizable in the vicinity of St. Louis. But a more

nearly correct idea of the true state of the case may be realized if the reader will bear in mind the two parent species and then imagine every possible form of gradation and combination producing races capable of self-propagation. If left to themselves without further contamination from their surroundings many would develop into good species. Var. *vestita* (*S. Missouriensis* Bebb) may thus be accounted for, which will be noticed later.

The modification of characters generally proceeds along the whole line with more or less equal pace, though often strong and weak modifications of one parent will be found indiscriminately combined with strong or weak modifications of the other, on the principle stated by Darwin "of augmentation, obliteration and reversion of characters when well defined varieties are crossed." When the departure from pure *S. sericea* is not too great, the increasing size of the stipules, the degree of discoloration in drying, the basal variation from the acute towards the cordate, the amount of silvery pubescence on the leaves are tolerably fair measurements of the distance. Beyond this the problem becomes more complicated. Taking our point of view from *S. sericea*, the important change first occurring is in the capsule. It loses its silvery pubescence, enlarges, lengthens in style and pedicel, assumes a somewhat flattish subrhomboidal base supporting a long or short beak with often a tendency to curve, ripens a pale tawny color, and has stigmas less deeply notched, often remaining entire.

The next important character early lost is the short, silvery, hairy coating of the under surface of the leaves. Instead, the leaves become more or less glaucous beneath, or the short hairs are transformed into the longer softer hairs seen on the young leaves of *S. cordata*. Var. *vestita* affords an extreme illustration of this process of change. No other character has received or demanded so much study as the one of pubescence or hairiness. Extremely variable in amount as to leaf, bud, shoot or twig, or absent altogether, variable also on scale and rachis, it is not a character of much value.

The third important change is in the scales. The scale

with broadly rounded apex and upper half black with sharp line of demarcation becomes narrower, oblong or obovate, with obtuse or acute apex dark to light brown, the line of demarcation less sharp and descending lower until it may be lost altogether.

Other changes follow, or are coincident with the preceding. The decided brittleness of *S. sericea* changes to semi-brittleness, to be finally lost in the toughness of *S. cordata*. The leaves become thicker, more glaucous beneath, subglossy above, losing the dull dark green upper surface, the prominent primary veins beneath, and the regular looping near the margin. They become larger, often long narrow lanceolate and long acuminate, the base changing from acute to obtuse, to round, and finally to cordate. The equilateral form in some instances becomes elliptic, in others oblanceolate or obovate, but in any case gradually loses the equilateral character.

From a total absence of stipules, or mere rudimentary processes, the change is rapid towards large semiovate or semi-cordate sharply pointed or acuminate, then to mixed, and finally to obtuse reniform forms, nearly all more or less stalked, this last being a new character not existing in either parent.

The bud of *S. sericea* is oblong, blunt, relatively short, notched at the apex, very finely exhibited in bursting. While the shape is soon lost in numerous variable forms, a common one being long wedge acuminate, the notch, though lessening in distinctness, often becomes a valuable aid in determining hybrids. The adherent inner membrane of the buds of *S. sericea* detaches itself in hybrids spontaneously, as in *S. cordata*, and is frequently carried as a cap on the apex of the ament.

The red color of the anthers of *S. sericea* is transmitted to the well marked hybrids, gradually changing, however, through brown or pale pink, into the yellow of *S. cordata*. The numerous prominent circular lenticels of *S. sericea* are still abundant in the better hybrids, becoming more and more mixed with the oval form as we approach *S. cordata*.

In *S. sericea* the epidermis of one and two year old twigs scales longitudinally, a character well retained by hybrids.

In this vicinity there is found on *S. sericea* a leaf gall, pyriform or globular in shape, about  $\frac{1}{4}$  in in diameter, enclosing a single larva of a species of saw-fly (*Nematus Salicis-pomum* Walsh), kindly identified for the writer by Miss Mary E. Murtfeldt of Kirkwood, Missouri. The same has been observed on some of the hybrids and on var. *vestita*, on two trees of the latter in extraordinary abundance. Not a single one have I seen on *S. cordata*, or on specimens approaching near to it, though growing side by side with those just mentioned! This fact is of the greatest importance, because it unites with a number of other facts showing that var. *vestita* is closer to *S. sericea* than to *S. cordata*.

Besides the transformations above noticed, the tendency to abnormalities has to be added. "Complexity of inheritance, like complexity in a chemical substance, gives instability to the offspring and thus liability to variation in the offspring."<sup>2</sup> The adnateness of filaments to the extent of 40 per cent. in hybrids, and 73 per cent. in var. *vestita* as shown in the summary, may be one of these abnormalities, but may be the usual character of *S. cordata*, though not heretofore noticed by any writer consulted. Related to this are cases where partly adnate filaments divide, making four filaments, each with a single anther cell; or the two filaments free, one of them dividing, thus making three stamens; or but a single stamen; or single stamen divided, each half filament bearing a cell; or the two stamens wholly united, bearing a double anther of four cells. More rare than the foregoing is the doubling of the ovary. There are also a few cases of strictly two-lobed styles, but more common are instances presenting both two and four-lobed styles on the same ament. In var. *vestita* the style is occasionally undivided, presenting a merely circular stigma, or with very indefinite divisions. The size of these hybrids may seem surprising, but all of our forms of *S. cordata*, as well as *S. sericea*, exceed the limits of the books. Pure *S. sericea* attains the height of 15 ft, with a diameter of  $2\frac{1}{2}$  in, though usually only 5 to 10 ft. As to our *S. cordata*, it is impos-

<sup>2</sup> LECONTE: Evolution, 218.

sible to assign limits, since it passes so gradually either into the hybrid form, or into var. *vestita*, this latter reaching a height of 40<sup>ft</sup> and a diameter of 10<sup>in</sup>. A remarkable thing is that *S. sericea* is quite rare, a pure specimen being found only amongst hundreds. I have spent a day in a region of some extent collecting undoubted hybrid forms, *S. cordata*., and var. *vestita*, without meeting with one pure *S. sericea*. This seems to prove clearly that these forms are not direct crosses but races. Indeed, I have been struck with the tendency of the plants in different localities to assume a sort of family resemblance.

The flowering period of *S. sericea*, its nearer hybrids, and var. *vestita*, is about the same; that of *S. cordata* and of hybrids approaching it is some days later. Honey bees appear to be the chief agents of pollination. In so many of the larger hybrids I have observed the bark of the lower portion of the trunk to be check-fissured, though of moderate depth, as to incline me to consider this as somewhat characteristic; but I have seen the same occasionally in trees which would be classed as var. *vestita*. The color is a dark gray or blackish. The bark of the *S. sericea* stem is smooth, and of light gray color. The arcuate primaries or looping near the margin of the leaf of *S. sericea* is a strong character, and is quite persistent in most of the hybrids; in other respects the venation generally resembles that of *S. cordata*.

In respect to the form named *S. Missouriensis* Bebb, I may be pardoned for regarding it as simply a race not separable either from *S. cordata* or the near hybrids, with nothing to distinguish it from these excepting, perhaps, its greater size or more tree-like form, and even this may be largely accounted for by the fact of the large trees being found growing in the richest soil. I have observed the same tree-like form, with hairy leaves, and of the same general aspect, growing in poorer soil, reduced to small stature. Its characters throughout are a compromise between *S. cordata* and *S. sericea*, with a closer leaning towards the latter. When compared with proven hybrids or races of those parents the resemblance is striking. The shape, color, vesture, thickness, drying color, want of gloss of the leaf, all

point towards *S. sericea*, as do the mostly round lenticels, the pointed stipules, the brittleness, the lithe twigs, the unfolding of the leaves towards the tip of the spray, and the leaf galls mentioned above. The instinct of the insect does not fail to detect the close alliance. I found this variety growing over the county wherever I collected: at Allenton and Valley Park belonging to the Meramec basin (trees 40<sup>ft</sup> high); north of Clayton, at the River Des Peres (trees 35<sup>ft</sup> high); near Fergusson, on upland ravine emptying into Moline creek (tree 30<sup>ft</sup> high and 7<sup>in</sup> in diameter). It can no longer be said, therefore, that it is confined to the rich bottom lands of the Missouri. I deem it unnecessary to say more on this point, as a reference to the summary will bear out the claims here made. It will be observed that having set down the variations of a character relating to a specimen the totals of such character will exceed the number of plants represented in that group.

In the comparison presented of *S. sericea* with *S. cordata* it is believed that a tolerably fair exhibit is given, at least sufficient to make evident the strong contrast between the two. Yet the writer has to confess the wish that his knowledge of *S. cordata* were more definite, and hopes that some one who has it in his power to secure sufficient material will undertake the task of a thorough review of this species remarkable for its free miscegenating proclivities, for besides *S. sericea* it also hybridizes with *S. petiolaris*, *S. candida*, *S. adenophylla*, *S. incana*, and *S. discolor*, none of which grow in this vicinity. I am under special obligations for specimens loaned by the following gentlemen: Professor J. Fowler, Canada; Mr. E. P. Sheldon, Minnesota; Professor F. D. Kelsey, Ohio; Professor L. H. Pammel, Iowa; Dr. William Trelease, Missouri Botanical Garden.

COMPARISON OF THE CHARACTERS OF SALIX SERICEA AND  
S. CORDATA.

*S. sericea.*

Usually small shrub, with slender stems, not over 15 feet high.

*S. cordata.*

Larger, tending to the tree form.

Twigs lithe, very brittle, nearly smooth, brown or olive green to light gray.

Epidermis thin, scaling.

Buds brown, oblong, blunt, notched at apex, inner membrane adherent.

Lenticels circular, numerous, prominent, brown or cinnamon color.

Leaves lanceolate, equilateral, base and apex acute; primary veins strong, prominent beneath and looping very regularly; upper side very dark green, under side subglaucous, coated with short silvery hairs; thin, drying black, and mostly affected with leaf galls; young leaves without color; serrulate.

Stipules none.

Aments about 1 inch long, with 2 to 5 leaflets, not tufted at base; scales short, broadly rounded, upper half black and clothed with rather stiff white hairs.

Filaments entirely free; anthers red.

Capsules short, oblong, blunt, clothed with short silvery hairs, bursting early; pedicel and style short; style 4-parted.

Blooming probably a week earlier.

A fixed, rigid species, with constant characters.

Tough, heavy, tomentose, blackish or blotched, changing to red or yellowish green and dark green.

Thick, firm, unbroken, not scaling.

Larger, ovate or wedge acute or the point flat, not notched, tomentose, then bright red or brown, inner membrane separating, being often carried to apex of ament.

Oval, relatively few, not prominent, color the same.

Apparently two forms: (1) long lance acuminate, (2) oblong-lanceolate, narrow or broad, cuspidate-acuminate; both obtuse to cordate, thick, inequilateral, glossy green above with a tinge of yellow, glaucous or subglaucous beneath; primaries relatively weak and looping only towards apex; drying yellowish green or light brown; young leaves downy above, hairy beneath, reddish.

Large, auriculate or reniform, obtuse (rarely acute), persistent.

Staminate 1.5 to 2 inches long, pistillate 2 to 4 inches, with 2 or 3 leaflets, tufted at base with long white hairs; scales narrower, oblong, obtuse to acute, light to dark brown, with softer more woolly hairs; gland longer.

Mostly more or less adnate; anthers yellow.

Mostly with subrhomboid, somewhat flattish base and narrowing to a beak of about equal length, or ovoid conical, not maturing so early; style long or medium, usually 4-lobed.

Variable with change of locality, and in same locality.



SUMMARY OF THE RECORD OF FIFTY-ONE SPECIMENS OF SALIX  
CORDATA × SERICEA, AND THIRTY-ONE SPECIMENS OF S.  
"MISSOURIENSIS."

	S. CORDATA × SERICEA			S. "MISSOURIENSIS"		
	STAMI- NATE <sup>1</sup>	PISTIL- LATE <sup>2</sup>	PER CENT.	STAMI- NATE <sup>3</sup>	PISTIL- LATE <sup>4</sup>	PER CENT.
Number recorded.....	28	23		15	16	
Twigs { brittle.....	13	12	53	9	5	47
Twigs { semibrittle.....	6	6	25	7	11	60
Twigs { tough.....	6	4	21	2	2	13
Buds notched.....	11	14	49	5	4	39
Lenticels { round.....	23	20	90	14	15	94
Lenticels { oval.....	19	14	69	13	11	80
Leaf form { lanceolate.....	15	15	59	7	8	48
Leaf form { narrow lanceolate.....	16	12	55	2	1	10
Leaf form { oblong lanceolate.....	11	7	35	12	10	71
Leaf form { elliptic.....	2	4	12	9	7	51
Leaf texture { thin.....	15	5	54	9	9	62
Leaf texture { thickish.....	9	8	46	5	6	38
Leaf surface { glaucous.....	6	2	16	13	14	87
Leaf surface (under) { subglaucous.....	22	21	84	2	2	13
Leaf surface { dull dark green.....	10	13	45	8	8	53
Leaf surface (upper) { yellowish green.....	5	4	18	0	* 0	0
Leaf surface { glossy.....	13	7	39	6	8	47
Leaf base { acute.....	21	21	82	9	13	71
Leaf base { obtuse.....	25	18	84	15	16	100
Leaf base { cordate.....	6	1	14	5	5	32
Leaf base { subcordate.....	3	4	14	9	4	42
Leaf base { round to truncate.....	5	7	23	1	5	19
Leaf apex { acuminate.....	27	23	98	9	10	61
Leaf apex { cusp.-acuminate.....	1	0	2	9	11	64
Stipules { pointed, semiovate.....	24	20	86	11	10	68
Stipules { obtuse, reniform.....	11	5	31	13	14	87
Stipules { stalked.....	16	7	68	5	4	35
Stipules { sessile.....	9	2	32	7	10	65
Color of young leaves { purplish.....	8	4	32	8	4	39
Color of young leaves { reddish.....	5	1	15	0	2	6
Color of young leaves { slight tinge.....	9	1	26	2	2	13
Color of young leaves { colorless.....	6	4	26	5	8	42
Filaments { free.....	24	0	60	4	0	27
Filaments { adnate.....	16	0	40	11	0	73
Anthers { red or brown.....	23	0	80	9	0	64
Anthers { yellow.....	15	0	54	12	0	86
Stigmas { 4-lobed.....	0	15	70	0	9	56
Stigmas { 2 to 4-lobed.....	0	7	32	0	7	44

ST. LOUIS, MISSOURI.

<sup>1</sup> Flowering March 29 to April 14; 15 were 15 to 25 feet high and 2 to 6 inches in diameter.

<sup>2</sup> Capsules ripe April 18 to 21; 12 were 15 to 25 feet high and 2 to 5 inches in diameter.

<sup>3</sup> Flowering March 29 to April 12; 11 were 20 to 30 feet high and 3 to 7 inches in diameter.

<sup>4</sup> Capsules ripe April 18 to 21; 13 were 20 to 35 feet high and 4 to 7 inches in diameter.